"The Effects of Temperature and Pressure on the Thermal Conductivities of Bodies. Part I.—The Effect of Temperature on the Thermal Conductivities of some Electrical Insulators."

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[Abstract.]

The substance whose thermal conductivity is to be determined has the form of a cylinder about 8 cms. long, 2 cms. diameter, and is surrounded by a thin cylinder of brass, which on account of its comparatively high thermal conductivity, makes the outer surfaces of the substance isothermal surfaces. The brass cylinder is placed in a Dewar tube.

The heat is supplied by the passage of an electrical current through a platinoid wire embedded in the substance parallel to the axis of the cylinder, and about ·4 cm. distant from it. The amount of heat generated is determined by the current through the wire and the potential difference between its ends. The temperature is measured by the electrical resistance of two short spirals of No. 40 pure platinum wire, down the centre of one of which the heating wire passes. To eliminate errors due to want of symmetry, a second heating wire passes down the centre of the second spiral, and the heating current may be sent through either or both at will.

The difference of temperature of the two spirals is determined by making them two arms of a resistance bridge, the other two arms of which are equal. By means of mercury cups resistances may be placed in series with either of the spirals till a balance is obtained. From the resistance necessary to effect the balance and the "fundamental constants" of the platinum thermometers which the two spirals constitute, the difference of their temperatures is calculated. The thermal conductivity k of the medium would, if the latter were infinite in extent and the heating wire infinitely long, be connected with the difference of the temperatures v_1, v_2 at the two points distant r_1 and r_2 from the heating wire, and the amount of heat H generated per second in 1 cm. of the latter, by the equation

$$v_1 - v_2 = \frac{H}{2\pi k} \log \frac{r_2}{r_1}.$$

In the apparatus used the connection between the quantities is not so simple, but the theory is worked out completely in the paper, and the corresponding expression given.

The following fairly representative substances have been tested each

at a number of temperatures between that of liquid air and the melting point of the substance: Ice, glycerine, aniline, paraffin wax, naphthaline, β-naphthol, para-nitrophenol, and diphenylamine.

The results show a marked increase of the conductivities of ice, naphthaline, aniline and nitrophenol, and a slight increase of those of β-naphthol, and diphenylamine at low temperatures. Glycerine has a maximum conductivity about $-80°$ C., and paraffin wax shows a tendency to behave in the same way.

A few values of the conductivities for a portion of the range of temperature are given in the following table:—

	At 120° abs.	At 180° abs.	At 240° abs.	Previous values.
Ice	0·0062	0·0058	0·0052	0·00568, Neumann, 'Ann. Ch. Phys.,' vol. 3, p. 66. 0·0050, Mitchell, 'Roy. Soc. Edin. Proc,' vol. 86, p. 592. 0·0014 liquid at 20° C.
Naphthaline.	0·0013	0·0011	0·00091	0·00096 at 33° C., Lees, 'Phil. Trans.,' A, vol. 191, p. 416.
Aniline	0·0011	0·00086	0·00070	0·00041 liquid at 12°, H. F. Weber, 'Berl. Ber.,' 1885.
Nitrophenol (para)	0·0010	3·00085	0·00070	
Glycerine	0·00078	0·00082	0·00076	0·00062 liquid at 13° C., Graetz., 'Ann. der Phys.,' vol. 25, p. 337. 0·00067 liquid at 12° C., H. F. Weber, *loc. cit.* 0·00068 liquid at 25° C., Lees, *loc. cit.*
Paraffin wax	0·00060	0·00065	0·00061	0·00061 at 35° C., Lees, 'Phil. Trans.,' A, vol. 183, p. 481.
β-Naphthol	0·00067	0·00065	0·00063	0·00081 at 32° C., Lees, 'Phil. Trans.,' A, vol. 191, p. 416.
Diphenylamine . . .	0·00058	0·00054	0·00052	

The temperatures are given in terms of the hydrogen scale, measured from the absolute zero, the thermal conductivities in c.g.s. units.

It will be noticed that the thermal conductivities are much greater in the solid than in the liquid state in the case of water and aniline, but almost alike in the case of glycerine.